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Abstract

Planning for Crew Exercise for Future Deep Space Mission Scenarios

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Providing the necessary exercise capability to protect crew health for deep space missions will bring new sets of engineering and research challenges.

Exercise has been found to be a necessary mitigation for maintaining crew health on-orbit and preparing the crew for return to earth's gravity. Health and exercise data from Apollo, Space Lab, Shuttle, and International Space Station missions have provided insight into crew deconditioning and the types of activities that can minimize the impacts of microgravity on the physiological systems.

The hardware systems required to implement exercise can be challenging to incorporate into spaceflight vehicles. Exercise system design requires encompassing the hardware required to provide mission specific anthropometrical movement ranges, desired loads, and frequencies of desired movements as well as the supporting control and monitoring systems, crew and vehicle interfaces, and vibration isolation and stabilization subsystems. The number of crew and operational constraints also contribute to defining the what exercise systems will be needed. All of these features require flight vehicle mass and volume integrated with multiple vehicle systems. The International Space Station exercise hardware requires over 1,800 kg of equipment and over 24 m^3 of volume for hardware and crew operational space. Improvements towards providing equivalent or better capabilities with a smaller vehicle impact will facilitate future deep space missions.

Deep space missions will require more understanding of the physiological responses to microgravity, understanding appropriate mitigations, designing the exercise systems to provide needed mitigations, and integrating effectively into vehicle design with a focus to support planned mission scenarios. Recognizing and addressing the constraints and challenges can facilitate improved vehicle design and exercise system incorporation.